Prospecting Infectious Disease Prevention through Water, Sanitation and Hygiene in a Dominican Batey

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Abstract

Diarrheal illness is a major contributor to the mortality of children under the age of five worldwide, as well as a significant burden on adult health and productivity in developing countries. Improvements in water, sanitation and hygiene (WASH) practices and infrastructure are important for decreasing the burden of infectious diseases, including diarrheal illness. The purpose of this study was to measure WASH knowledge and practices in a particularly vulnerable batey—a rural settlement of Haitian migrant workers along the Dominican-Haitian border—and to determine whether a WASH-based participatory health and hygiene education (PHHE) program would be beneficial to the community. A cross-sectional household survey of 88 homes out of an estimated 200 in Batey Altagracia was conducted to measure perceptions, knowledge and practice of WASH principles. Composite knowledge scores were calculated and analyzed for associations with demographics, social factors and WASH practices. Overall, participants demonstrated low knowledge of WASH principles. In particular, respondents lacked knowledge regarding parasitic worm prevention, skin disease prevention, protected water sources and how to make a homemade oral rehydration solution. Though water treatment and handling practices in the community were generally good, insufficient hygiene and sanitation may contribute to an increased risk of infectious disease transmission in an already economically and socially disadvantaged community. From our findings, we concluded that a PHHE program would be beneficial to improving WASH practices in the community and disrupting the cycle of poverty and disease.

Introduction

Improvements in water, sanitation and hygiene (WASH) practices and infrastructure may be one of the most important and cost-effective methods for decreasing the burden of infectious diseases worldwide (Jamieson, Bremen, Measham, Alleyne, & Claeson, 2006). Insufficient hygiene and sanitation practices and infrastructure are associated with a multitude of diseases, including acute respiratory tract infections, skin diseases such as scabies and ringworm, intestinal parasites and diarrheal illness (Bartram & Cairncross, 2010; Luby, Agboatwalla, Feikin, Painter, Billhimer, Altaf, & Hoekstra, 2005). Diarrheal illness alone is the second leading cause of death globally in children under the age of five, and subsequent malnutrition exacerbates children's vulnerability to many other illnesses (*Diarrhoeal disease*, 2009; Schmidt, Cairncross, Barreto, Clasen, & Genser, 2009). However, this burden of disease is not just in children; "every year across the globe around two million people die of diarrheal illness" *(Diarrhoeal disease*, 2009). Furthermore, diseases associated with insufficient WASH likely contribute to 82,196,000 disability-adjusted life years (DALYs) of lost productivity, which in 2002 was estimated to account for 5.7% of total world DALYs (Rosen & Vincent, 2001; Pruss, Kay, Fewtrell, Bartram, 2002).

Fortunately, most of these diseases are preventable with improvements in WASH practices and infrastructure. Increases in hand washing alone decrease the prevalence of diarrheal disease by 42%, while improvements in hygiene cause a 33% reduction and sanitation a 36% reduction, according to rigorous studies in developing countries (Fewtrell et al., 2005). In particular, educational interventions that integrate clean water, sanitation and hygiene topics were shown to result in sustained decreases in diarrheal diseases, as assessed five years post-intervention (Hoque, Juncker, Sack, Ali, & Aziz, 1996).

The Dominican Republic is particularly vulnerable to endemic and epidemic diarrheal illnesses due to decreased rates of access to improved drinking water sources along its border with Haiti, a nation with an ongoing cholera epidemic (Dominican Republic, 2007). This reduced water access has documented associations with population growth, but our observations also implicate an inconsistent and/or non-existent supply of public services, which is a problem that extends to sewage and solid waste disposal (Dominican Republic, 2007).

Since the 2010 earthquake in Haiti, incidence rates of cholera have increased in Dominican provinces closest to the Haitian border ("Cholera and post-earthquake response in Haiti", 2011); similarly, this heightens the risk of diarrheal illness and mortality. The infant mortality rate in the Dominican Republic

is 33/1000, well above the World Health Organization's regional (Region of the Americas) average of 18/1000 live births for children under the age of five ("Demographic health survey 2007", 2008). The major causes of under-five mortality include acute respiratory infections (70%), isolated fever as a proxy for Malaria (68%) and diarrhea (55%) ("Demographic health survey 2007", 2008). Notably, acute respiratory infections and diarrhea are associated with inadequate WASH practices.

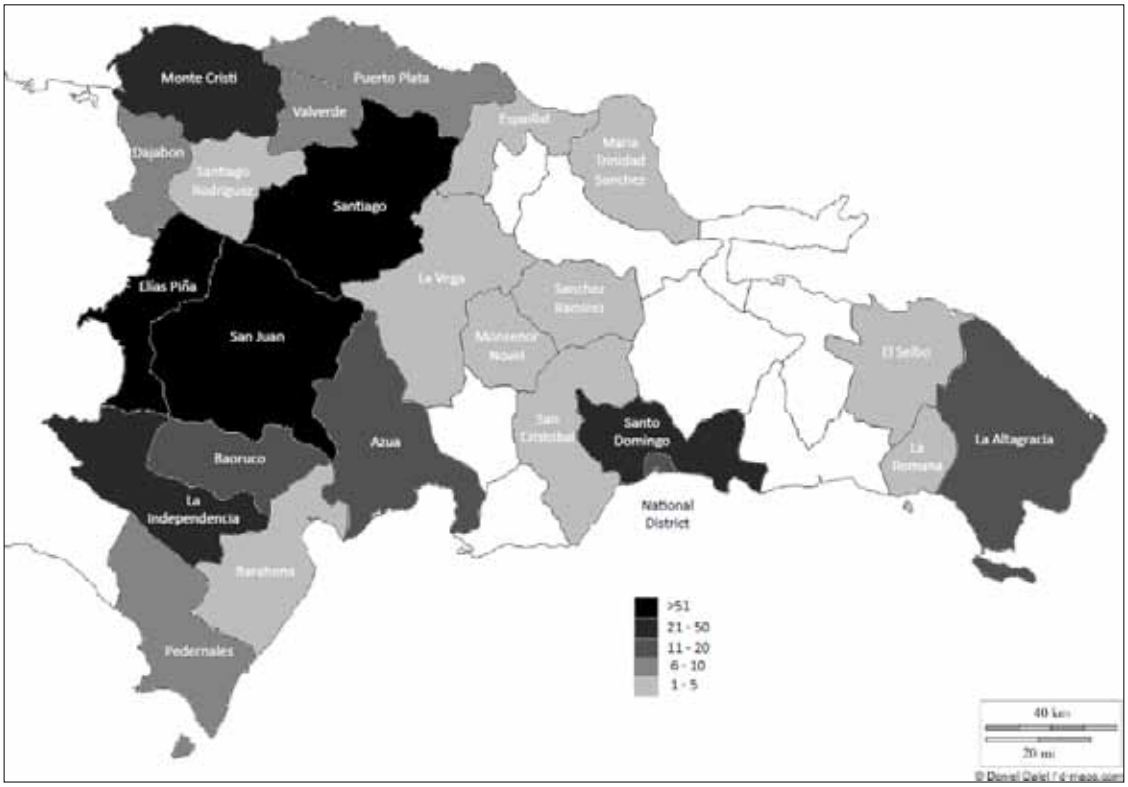

Figure 1: Cumulative Incidence of Confirmed Cholera Cases, by Province, Oct 2010 - Feb 2011. Batey Altagracia is in the Barahona Province. Map created by J. Rosenfeld

Those populations in the Dominican Republic who are most likely to be exposed to cholera are those who are already most vulnerable to WASH illnesses. Bateyes are rural communities formed by both permanently displaced Haitians and migrant Haitian workers who do seasonal agricultural work. In the Dominican Republic, 68.7% of rural residents, including bateyes, are in the lowest two wealth quintiles; this is the best available estimate of wealth for bateyes, since research on bateyes is scant and public health statistics are inconsistently documented in the Dominican Republic ("Demographic health survey 2007", 2008). Additionally, bateyes have a higher infant mortality rate (41/1000) than the rest of the country ("Demographic health survey 2007", 2008). Importantly, the seasonal migration, emergency/evacuation associated migration and permanent relocation patterns between Haiti and the Dominican Republic place these communities at higher risk for spread of cholera and any epidemic illness originating in Haiti. Socioeconomic status contributes to increased risk of diarrheal illness mediated by factors such as sanitation and infrastructure. In one study, 25% percent of this risk was accounted for by WASH practices (Genser et al., 2008). WASH practices are part of the link between poverty and disease. Disrupting this link in a batey could help mitigate the health disparities and the impact of the burden of WASH-related disease in the community.

It is the social and economic vulnerability of these communities as well as the threat of cholera that led us to conduct an assessment of the WASH knowledge and practices in one Dominican batey along the Dominican-Haitian border, Batey Altagracia. Our goal was to determine whether a WASH education program would be an appropriate infectious disease prevention strategy for bateyes in the region. Batey Altagracia is in the Barahona province of the Dominican Republic, which is adjacent to the current centers of the cholera epidemic in the Dominican Republic (See Figure 1). The incidence of diarrheal illness in this region (24%) is significantly higher than the national average of 14% ("Demographic health survey 2007", 2008). We hypothesize that this community will be a good site to pilot a participatory health and hygiene education (PHHE) program originally developed in Africa called the Community Health Club approach (Waterkeyn & Cairncross, 2005). The Community Health Club approach integrates principles of participatory hygiene and sanitation transformation (PHAST) like community mobilization into the framework of a community group dedicated to promoting health knowledge and good health practices (Waterkeyn et al., 2005). This methodology builds on existing social capital and also strengthens social ties by creating a new framework and forum for community involvement.

At present, there is a lack of data and peer-reviewed literature on WASH practices and interventions in the Dominican Republic and bateyes, specifically. The national demographic and health survey of the Dominican Republic, which focused on behaviors related to HIV transmission, is the only published survey of disease prevention in the country. There have been no published surveys focused on WASH practices in bateyes; there are two published WASH surveys in peri-urban and rural areas (Belcher, 1978; McLennan, 2000; McLennan, 2002). Additionally, although there are published evaluations of bio-sand filter interventions in the Dominican Republic (Stauber, Ortiz, Loomis & Sobsey, 2009), there are no published evaluations of WASH education interventions.

Methods

Study Area and Population

Using a modified cluster sampling technique, we conducted a cross-sectional household survey of 88 homes in Batey Altagracia, a small community located within the Fundación Municipality of the Barahona Province. We conducted our work

Table 1: General demographics of needs assessment respondents in Batey Altagracia, 2011

Characteristic	N (%)
Gender	
Male	24 (27.3)
Female	64 (72.7)
Age (year)	
18-25	24 (27.3)
26-35	25 (28.4)
36-45	10 (11.4)
46-55	10 (11.4)
56-65	6 (6.8)
65+	13 (14.8)
Marital Status	
Married , living with spouse	19 (21.6)
Married, living without spouse	3 (3.4)
Unmarried, living with partner	26 (29.5)
Single with children	25 (28.4)
Single without Children	11 (12.5)
Widowed	4 (4.5)
Literacy	
Both read and write	36 (40.9)
Only read	3 (3.4)
Neither read nor write	49 (55.7)
Education	
None	33 (37.5)
Primary School	36 (40.9)
High School	15 (17.0)
University	4 (4.5)
Work	
Both Full-Time and Part-Time	4 (4.5)
Full-Time	9 (10.2)
Part-Time	64 (72.7)
None	11 (12.5)
Type of Part-Time Work	
Unskilled Manual Labor	45 (66.2)
Skilled or Trade Worker	6 (8.8)
Farming/Agriculture	8 (11.8)
Informal Trader	13 (19.1)
Home Crafts	
Domestic Worker	2 (2.9)

Table 2: Water sources, storage, protection, and treatment

Water Practice Categories	N (%)
Drinking Water Source	
Tap	51 (58.0)
Bottled Water	37 (42.0)
Type of Storage	
Bucket	47 (56.0)
Drum	26 (31.0)
Jerican	2 (2.4)
World Vision Container	32 (36.8)
Water Cover	
Well Sealed	66 (82.5)
Poorly Sealed	8 (10.0)
No Cover	6 (7.5)
Drinking Water Source	
Tap	51 (58.0)

during the summer of 2011 between June 6 and June 17.

Tools: Survey and Measures/Scales

The survey utilized in our study was adapted from a Household Interview Survey (HIS) previously used in Sub-Saharan Africa to gather baseline data. The original survey was designed to assess levels of social capital and to evaluate perceptions, knowledge and practices of WASH principles in rural community settings (Rosenfeld & Waterkeyn 2009; Rosenfeld 2010 citations). In particular, the survey was aimed at measuring the current levels of knowledge and behaviors in the community that prevent the transmission of diarrhea, skin diseases, parasitic worms, mosquito-borne diseases, such as malaria and dengue fever, and respiratory conditions. Our team piloted the translated Spanish survey for four days in the neighboring communities of Barahona and Batey Algodón. This ensured that the survey was linguistically and culturally appropriate for Batey Altagracia. A specific example of a linguistic adaptation was the use of

Table 3: Human and solid waste disposal practices

Sanitation Categories	N (%)
Latrine Type	
Donor/Government VIP	32 (38.6)
Home-made VIP outside	5 (6.0)
Home-made pit latrine	2 (2.4)
No latrine/bush	44 (53.0)
Waste Disposal Method	
Household Pit/Dump/Drum	59 (67.0)
Community Pit/Dump/ Drum	30 (34.1)
Plastic Bag	37 (42.0)
Anywhere	1 (1.1)
Canal	2 (2.3)

Table 4: Personal and kitchen hygeine

Hygeine Categories	N (%)
Hand Washing Method	
Common bowl method	19 (22.4)
Pouring water over hands	43 (50.6)
Using a tap outside	21 (24.7)
Hand washing facility	2 (2.4)
Flies in Kitchen	
No flies	15 (17.2)
A few flies	38 (43.7)
Many flies	34 (39.1)
Kitchen Surfaces	
Clean	18 (21.4)
Medium or quite clean	34 (40.5)
Dirty	32 (38.1)
Dish Cleanliness	
All washed	24 (27.9)
Some clean, some unclean	54 (62.8)
All left unwashed	8 (9.3)
Covering of Leftover Food	
All covered	14 (15.9)
Some food covered	25 (28.4)
All uncovered	6 (6.8)
No visible food	43 (48.9)

the more colloquial phrase *suero casero* rather than *rehidratación oral* when referring to an oral rehydration solution. As for the cultural aspects of the survey, we confirmed that questions like "Do all your children have the same father?" were not offensive to respondents in the Dominican Republic.

Pre-testing of the survey allowed our team to train our translators, standardize the interview process and accurately define the categories and guidelines for the observations. Through 74 open- and close-ended questions and 32 observations, our survey measured the following:

Demographics

Demographic data was collected from each respondent, including information on marital status, literacy, education level and vaccination card status of the children in the household. Marital status was defined as having an official marriage certificate. Seven responses were provided to determine the current marital status of individuals (1 = Married, living with spouse, 2 = Married, living without spouse, 3 = Unmarrried, living with partner, 4 = Divorced, 5 = Single without children, 6 = Single mother/father, 7 = Widowed). Self-reported information about the respondent's education level and literacy was obtained by asking individuals "What was the last level of schooling that you completed?" and "Do you know how to read and write, to read only, or neither to read nor to write?" Education level was based on the educational system in the Dominican Republic (1 = Primary School, 2 = High School, 3 = University, 4 = Licensed, 5 = Doctorate, 6 = None). Information about the children living in the household was also obtained, including the reported number of children who had a vaccination card.

Social Capital

Respondents were asked about their friends and acquaintances to understand the social networks within the community. One question we used to measure this was, "How many of your neighbors within the surrounding 20 houses do you know by name (first name, last name or nickname)?" Participant responses were based on whether they knew the name of at least one member of each household and were recorded in the number of households from 0-20.

WASH Perceptions

Perceptions of the sanitation of the community were measured by asking respondents about how they felt about specific issues within the community. Participants were asked, "Is the disposal of garbage a problem in your community?" Respondents were offered three options to these questions (1=Yes, it is an important problem, 2=Yes, it is a minor problem, or 3=No, not at all).

WASH Knowledge

Respondents were asked a series of five knowledge questions, each with a possible five correct answers. These questions included: five ways diarrhea is transmitted, five times to wash hands, five ways parasitic worms are prevented, five ways skin diseases are prevented and five sources of safe/protected water. Correct answers to these knowledge questions were predetermined and participants were later scored. A point was given for each correct response, with a maximum of five possible points per question. Respondents were also asked for the recipe for a homemade oral rehydration solution (ORS), an important tool for combating the dehydration associated with diarrheal illness. Knowledge of ORS can help prevent deaths due to dehydration secondary to diarrhea. Correct responses needed to include the exact proportions (8 level teaspoons of sugar plus ½ level teaspoon of salt to 1 liter of clean water) of the proper ingredients.

WASH Practices

Determining WASH practices was accomplished through survey questions as well as direct observations of the household, including the kitchen area, which were made by the enumerators after asking permission to view the home. Questions such as "Do you have access to a latrine?" and "Do you store water inside (or outside) of your home?" provided information about sanitation and water practices, respectively. These variables were dichotomous (1=Yes and 2=No). Observations aimed at measuring WASH practices included, "Is all leftover food protected from flies?"(0=Not applicable, 1=Yes, all covered, 2=No, some food protected, 3=No, all left uncovered) and "How well is the drinking water covered?" (0=Not applicable, 1=Well sealed, 2=Poorly sealed, 3=No cover at all). For the observation related to hand washing method, the team member asked to wash his or her hands, and then observed whether soap was given and how water was provided (1=Pouring water over hands, 2=Bowl method, 3=Hand washing facility, 4=Other, 5=Outside tap). This is a more accurate representation of practice than the self-reported hand washing method.

Data Collection Procedures

All interviews were conducted over a five-day period. We used a modified cluster random sampling technique to assure that the interviews were conducted randomly. We accomplished this by geographically dividing the community into three comprehensive and mutually exclusive clusters or divisions according to an aerial map provided by a community member. Each member of the team was then assigned a cluster and used a random number for the household selection. Each team interviewed households in their cluster from one edge to the other according to their drawn number. If a team member encountered a household that was unwilling to participate or not available, he or she continued to the next immediate house until a participant was identified. Every possible effort was made to ensure that households were not duplicated. During data collection, each team member worked individually as an enumerator along with two bilingual translators. One translator spoke English and Spanish and the other translator spoke Spanish and Haitian Creole. The surveys were conducted in the language identified by the enumerators as the preferred language of the individual. The average interview took 30-45 minutes to complete.

Data Management and Analysis

All data was double-entered by two team members and compared in order to eliminate data entry errors. Data was then analyzed using IBM SPSS Statistics 19. Duplicates were confirmed within the data set by comparing the variables for "Gender," "Age," "Birthplace" and "Years in the batey." If duplicates occurred, the data was withheld from the analyzed data set. Averages were calculated for demographic information such as "Household size" and "Number of children in the household." Averages were also calculated for measures of social capital including "Number of neighbors known by name" and "Number of close friends." Numerical modes were determined for the number of correct responses to each knowledge question to represent the knowledge of most respondents.

In order to determine associations between demographics/social factors and knowledge as well as behavior

and knowledge, a composite knowledge score was calculated for each participant. This was done by adding the scores of each knowledge question except the question about clean water sources. Exclusion of the clean water sources question was necessary as it was not an accurate measure of knowledge—respondents who listed tap water as a clean water source along with bottled water received a higher score than those who only listed bottled water, despite the fact that in this setting tap water is often contaminated. Composite knowledge was then binned based on lower (<=4), middle (5-6), and upper thirds of all the scores (7+), so that we could examine any associations with demographic factors, literacy, education, social capital, news sources and behaviors in this batey. Once a composite knowledge score was obtained, Pearson's Chi-square test was utilized to determine associations.

Ethical Considerations

Our study qualified for exemption from the Institutional Review Board (IRB) at the University of Texas Health Science Center at San Antonio (IRB HSC20110374E) because our research involved minimal risk to participants and did not include individuals under 18 years of age. To ensure that our respondents were fully informed, we read aloud an informed consent in Spanish. Although the vast majority of respondents were born in the Dominican Republic and spoke Spanish, for those individuals who did not speak Spanish, the informed consent was translated into Creole and the interview was conducted by a Creole translator. Participation in our study was strictly voluntary, and participants did not have to answer questions if they felt uncomfortable. Participants were permitted to stop the survey at any time. To protect the identity of our participants, we did not collect personal information, such as name, address or telephone number. When data was not in use by team members, it was stored behind a locked door or password protected on a computer.

Results

Demographics of Study Population

The demographic characteristics of the study population are outlined in Table 1. The majority of respondents were not legally married but were living in a free union with their partner (29.5%), and many had no formal education (37.5%) or only had primary education (40.9%). The average household size was 5 (SD=2.78; 1-13), and there were an average of 3 (SD=2.37) children per household. In those households with children, there were an average of 2 vaccination cards per household (N=74). Most respondents were born in the Dominican Republic (83.9%, N=73) and were raised in Batey Altagracia (72.3%, N=60).

Community Involvement, Social Capital and Sources of Information

Measures of community involvement indicated that 39.8% of interviewees participated in volunteer activities such as cleaning and improving the unpaved streets within the community (N=35), and 32.2% attended at least one meeting to discuss the betterment of the community in the last year (N=28).

The average respondent knew the names of 18 (SD=4.29) out of 20 of their nearest neighbors and reported having 6 (SD=7.88) good friends in the community, to whom they can go to for help and advice in times of need. In addition to connections within the community, a majority of respondents reported having a source of news or current events. Only 10.2% of respondents had no news source (N=9). Of the available news sources, the most common were television (69.3%, N=61) and radio (54.5%, N=48).

Self-confidence and self-efficacy were measured using shyness and capacity to change one's own life as proxies. Of those interviewed, 23.9% reported feeling shy in public meetings or gatherings (N=21) and 77.3% felt that they had the capacity to change their life in whatever way they wanted (N=68).

Measures of Behaviors

Water

In investigating the community's water sources, we found that the majority of those interviewed used tap water for drinking (58.0%, N=51), with the remainder drinking bottled water (42.0%, N=37). For both those who did and did not buy bottled water, chlorine was the most common drinking water treatment method (89.2%, N=58). Most households stored water (98.8%, N=81) in well-sealed containers (82.5%, N=66). The most commonly used storage methods are shown in Table 3. Most households had a vessel for serving water visible in their kitchen, such as a ladle, cup or pitcher (56.5%, N=48), and the majority had enough visible cups for everyone in the household (71.6%, N=63).

Sanitation

Sanitation practices were measured through questions about human waste (latrine access), solid waste (trash disposal) and grey water management. In this sample, 49.4% reported access to a latrine (N=43), and of those with access, 51.2% owned the latrine they used (N=22). See Table 3 for latrine types. On average, each latrine was shared by 10 people, with a minimum of 1 person and a maximum of 30 people per latrine. Fifty-four percent of latrines were observed to be clean, with no visible fecal mater, urine or trash inside (N=20), but only 21.6% were well-sealed, with a lid or cover over the opening so no flies could enter or exit the vault (N=8). The majority of respondents did not find trash disposal to be a problem (55.7%, N=49); however, trash was seen within five paces of 89.8% of homes (N=79). Most of the respondents reported disposing of solid waste in either household or community dumps (See Table 3) with the waste subsequently being burned (41.4%, N=36) or removed by a garbage truck (47.1%, N=41). About two-thirds of participants recognized rodents as a big problem in the community (68.2%, N=60).

Hygiene

Hygiene was assessed through demonstrations of hand washing and observed kitchen hygiene. The principle methods of hand washing were pouring water over hands (50.6%, N=43) and using a tap outside the house (24.7%, N=21). 47.1% of participants did not provide soap for hand washing. Kitchens were generally partially clean: most cooking surfaces in kitchens were medium clean or quite clean, defined as having little to no visible dirt, food or remnants (40.5%, N=34), some food but not all was covered if visible (55.6%, N=25), some but not all dishes were clean (62.8%, N=64) and most kitchens had a few flies—one or two but not a continuous buzzing (43.7%, N=38, See Table 4).

The use of shoes and mosquito nets are direct ways of preventing exposure to disease vectors and fomites. At each home, an average of 29.2% of the household members were

barefoot (N=87, Range 0-7), while most households had at least one mosquito net (64.8%, N=57).

Knowledge

There were two respondents (2.3%) to the survey who could give an oral rehydration solution recipe, though the proportions were incorrect. The rest of respondents had no knowledge about homemade oral rehydration solutions (97.7%, N=86).

The following are the numerical modes followed by the ranges for correct responses to the knowledge questions (the maximum score was 5): diarrhea (2, 0-3, N=28), hand washing (3, 1-5, N=37), parasitic worm prevention (0, 0-4, N=60), skin disease prevention (0, 0-4, N=46) and protected water sources (1, 0-3, N=51).

Associations of Demographics/Social Factors and Knowledge

We did not find significant associations between the binned composite knowledge score and birthplace (p=0.18), number of close friends in community (p=0.11) or self-reported literacy (p=0.14). Those with low education (p=0.002) and those who did **not** attend meetings (p=0.010) were more likely than expected to have low overall knowledge (See Supplementary Table 5). Additionally, respondents with television as a news source were more likely than expected to have high levels of knowledge (p<0.001, See Supplementary Table 5).

Associations with Knowledge and Behaviors

We did not find significant associations between binned composite knowledge and use of soap (p=0.076), observed latrine type (p=0.60), trash near home (p=0.41), covering of drinking water (p=0.45) and animal feces (p=0.18). Those with higher knowledge tended to have more vaccination cards than expected (p=0.017); likewise, those with less knowledge were less likely than expected to have a vessel for serving water (p=0.026). Those with higher knowledge more often than expected had fewer visible cups than people in the household (p=0.032, See Supplementary Table 5).

Migration patterns between Haiti and the Dominican Republic place these communities at higher risk for spread of cholera and any epidemic illness originating in Haiti.

Discussion

With the ongoing cholera epidemic in Haiti and now in the Dominican Republic, WASH practices and interventions are especially relevant on the island of Hispaniola. We found that overall knowledge of WASH practices within this community were low, especially with regards to parasitic worm prevention, skin disease prevention and protected sources of water. We also found that, overall, hygiene and sanitation were insufficient and could contribute to an increased risk for diarrheal illness in the community.

Scores for individual knowledge questions indicated that the community had more knowledge of correct hand washing practices and causes of diarrheal illness. Despite this, there were few correlations within our data that would suggest that higher overall knowledge is contributing to better WASH practices within individual households. Although there was a correlation between composite WASH knowledge scores and having a water-serving vessel, there were no associations with important practices like the use of soap for hand washing and covering stored water. This could be because knowledge scores are quite low, with all but one respondent receiving a composite score of 10 points or fewer out of a 20-point scale. Alternatively, knowledge alone may not be sufficient to alter behavior in settings where non-knowledge barriers, such as a lack of financial or material resources, exist, as has been previously suggested (McLennan, 2000).

Good water treatment and handling practices have been shown to decrease the incidence of diarrheal diseases (Fewtrell et al., 2005), and adequate water storage and treatment practices had already been implemented in a majority of households—including water chlorination (self-reported), proper sealing of storage containers and the use of a serving vessel. However, poor sanitation and hygiene practices still place community members at great risk of contracting infectious diseases, including parasitic worms, respiratory, skin and diarrheal illnesses (Bartram & Cairncross, 2010).

Open defecation and unsealed latrines in particular pose a high risk of fecal-oral disease transmission, since 53% of households had no access to a latrine and 78.4% of latrines were not well-sealed. Anecdotal evidence suggested that many of the respondents lacking latrines would defecate in the nearby sugarcane fields, and that burial of fecal mater was uncommon, which exposes field workers to fecal matter. On average, ten persons shared a latrine. Those sharing latrines were probably immediate and extended family members, since there were often several generations of one family living in the same area of the community. Latrines likely filled more quickly due to the practice of sharing, and once full, latrines were abandoned and community members returned to open defecation. The large number of full or disused latrines within the community raises concerns about the utility and sustainability of current sanitation technologies, which are dependent on donor or government funding and demonstrate a reduced life span due to the high number of persons sharing a single latrine.

Hand washing is one of the most important practices for interrupting the cycle of fecal-oral transmission (Fewtrell et al., 2005). Although only a few of the households (22.4%) used the common bowl method for hand washing, its use in the local elementary school contributes to increased risk for bacterial cross-contamination. The lack of soap use in almost half of the households also increases the risk of diarrheal and upper respiratory illnesses (Bartram & Cairncross, 2010).

Solid waste management practices also appear to be inadequate. Although most participants reported disposing of solid waste either in a household or community dump, pit or drum, littered trash was observed to be present near 89.8% of homes in the community. Poorly managed solid waste can serve as a breeding ground for rodents and other disease vectors, as evidenced by the findings that rodents were perceived to be a problem in 80.7% of households. In contrast, the majority of

respondents, 55.7%, did not view the littered and accumulated waste in the community as a problem. The lack of concern about waste management in the face of abundant litter and rodent problems could be due to differences in the perception of solid waste management or insufficient knowledge of the chain of disease transmission.

Despite some knowledge of appropriate WASH practices, there seems to be little knowledge of how to respond to acute diarrheal illness. No one surveyed could provide a correct recipe for a homemade ORS. A large number of participants instead noted that packets of ORS could be purchased and mixed with 1 liter of boiled water. A previous study of a peri-urban Dominican community showed that 90% of respondents could describe how to prepare a premade packet of ORS, but only 21% had ever used a homemade ORS (McLennan, 2002). Reliance on prepackaged satchels of ORS creates undesirable financial obstacles to oral rehydration therapy in low-income communities (McLennan, 2002) and reduces access to a life saving remedy for severe diarrheal diseases.

Strong social networks within the community, moderate levels of involvement, and high belief in self-efficacy could be beneficial for adopting and diffusing improved behaviors.

There were several demographic and social factors associated with WASH knowledge that may help explain the primary sources of WASH information for this community. As expected, higher education levels were correlated with higher WASH knowledge. Additionally, it seems likely that public service announcements on television targeting cholera prevention contribute to the correlation between television as a news source and knowledge scores, by increasing knowledge about diarrhea and hand washing. Interestingly, the correlation between knowledge and attending meetings to better the community may be due to non-governmental organizations (NGOs) periodically including health education components in their community meetings. Several participants noted that community meetings were usually sponsored by NGOs. This periodic rather than long-term health-related intervention could also explain the increase in knowledge without subsequent behavior change. While we expected that social networking within the community might be an influential means of information dissemination, no such correlations were found. One reason for this could be that there are no vocal sources of WASH information in the community and no forum in the community in which to discuss health and hygiene. Currently, sources from outside of the community seem to be the primary determinants of WASH knowledge in Batey Altagracia.

There are several limitations inherent in the methods of this study, including ineffective sampling and compromised internal and external validity. Though we used a modified cluster sampling technique, the layout of the community and inaccuracy of the map used posed challenges to ensuring that clusters did not overlap. In some cases households were visited twice, but all data was checked to ensure duplicates were removed from the data set. The disproportionate number of females and adults under the age of 35 may decrease the applicability of these results to older and/or male members of this batey. Also, enumerator biases for subjective observations, such as those for evaluating cooking surface cleanliness, were likely and may have contributed to the lack of significant associations between knowledge and these variables. Finally, while living conditions in many bateyes throughout the Barahona Province are similar, the results of this survey cannot be generalized to populations outside of Batey Altagracia.

Despite the limitations of our study, we believe that the work conducted contributes to the evaluation of WASH knowledge and practices in Dominican bateyes, a topic on which there is little published research (McLennan, 2000; McLennan, 2002; Stauber et al., 2009). Moreover, our findings are potentially very important for designing interventions to disrupt the disease transmission between Haiti and the Dominican Republic. Additionally, through pre-testing our survey to ensure cultural and linguistic appropriateness in differing communities, we believe that we have developed a valuable tool for baseline assessment as well as monitoring of WASH interventions in the Dominican Republic.

Conclusion

Batey Altagracia, with its low levels of WASH knowledge and varying degrees of implementation of good practices, would benefit from a WASH-focused PHHE program. Strong social networks within the community, moderate levels of involvement and high belief in self-efficacy could be beneficial for adopting and diffusing improved behaviors through a Community Health Club, which would serve as a forum for addressing health and hygiene concerns and for creating demand for improved WASH infrastructure, such as latrines and point of use water treatment techniques. The results of our survey showed that sanitation practices in particular may be an area to focus on, including the exploration of appropriate and sustainable means of human and solid waste disposal to reduce fecal-oral disease transmission and vector-borne diseases. The baseline data collected will be valuable in guiding future interventions in Batey Altagracia and ensuring that WASH programming is appropriate for the community, including considerations of education levels and social structure. Finally, the survey tool we developed will be valuable in assessing WASH practices in similar rural settings within the Dominican Republic and evaluating post-intervention improvements.

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Supplementary tables and figures for this article are available at JGH Online, www.ghjournal.org

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